SHUL'MAN, M.S.; APATTSEVA, V.A.

Sorption of ferments by sefadex. Ferm.i spirt.prom. 31 no.1:14-16 '65. (MIRA 18:5)

1. Vsesoyuznyy nauchno-issledovatel'skiy institut fermentnoy i spirtovoy promyshlennosti.

SHUL'MAN, M.S.; APATTSEVA, V.V.

Effect of electrolytes on the settling of amylase enzymes from Aspergillus pryzae. Trudy TSNIISP no.12:35-39 '62. (MIRA 17:3)

APAVALOAEI, Corneliu, ing.

From the experience of socialist units. Mec electrif agric 9 no. 4:33-37 '64.

1. Ciulnita Repair Station.

ALAVAIOAIEI, M.

Industry of the city of Botosani. p. 231.

ANALELE STIINTIFICE. SECTIUNEA II: STIINTE NATURALE. Iasi. Rumania. Vol. 5, no. 1, 1959.

Monthly List of East European Accessions (EEAI) LC, Vol. 9, no. 1, January 1960.

Uncl.

[illegible], P.; [illegible], V.; MAVALOGHI[illegible], M.; [illegible], [illegible].

Economic and geographical contributions on the city of F[illegible]eni. Anal St Jassy [illegible] 10:147-158 '64.

1. Submitted October 26-27, 1963.

APAYEV, B. A.

.PHASE I TREASURE ISLAND BIBLIOGRAPHICAL REPORT AID 350 - I

BOOK Call No.: TN672.V8

Author: APAYEV, B. A.

Full Title: SIGNIFICANCE OF CARBON IN THE FORMATION OF INTERMEDIATE CARBIDE PHASES

Transliterated Title: Rol' ugleroda v obrazovanii promezhutochnykh karbidnykh faz

Publishing Data

Originating Agency: All-Union Scientific Engineering and Technical Society of Machine Builders. Urals Branch

Publishing House: State Scientific and Technical Publishing House of Machine Building Literature ("Mashgiz")

Date: 1950 No. pp.: 15 No. of copies: 3,000

Text Data

This is an article from the book: VSESOYUZNOYE NAUCHNOYE INZHENERNO-TEKHNICHESKOYE OBSHCHESTVO MASHINOSTROITELEY. URAL'SKOYE OTDELENIYE, THERMAL TREATMENT OF METALS - Symposium of Conference (Termicheskaye obrabotka metallov, materialy konferentsii) (p. 190-204), see AID 223-II

Coverage: On the basis of early investigations conducted by A. P. Arbuzov, G. V. Kurdyumov and I. V. Isaychev, the intermediate carbide phase Fe_xC was believed to be distinctly different from common cementite. However, later study shows that the carbide formed during annealing of tempered steel does not differ from cementite. Specific changes in the X-ray pictures taken at different temperatures of annealing indicate a special form of carbide particles and their dispersibility. The results lead to new study of the nature of the "third transformation" for the explanation of effects observed particularly in the region of 400° - 300°C. The study was conducted on various carbon steels by the magnetic method related to: the phase composition at different annealing temperatures; carbon formation at intermediate carbide phase; anomaly in the intensity of the magnetization curve; quantitative characteristic of decomposing reaction of Fe_xC and to many other problems of similar nature.

The experimental results lead to many interesting conclusions mentioned in the text. 7 charts, 6 tables.

Purpose: For scientific workers

Facilities: None

No. of Russian and Slavic References: 10 (1939-49)

Available: Library of Congress.

Nature of martensite. [illegible] *Dokl. Akad. Nauk SSSR* 1954, 93, 647–649. The [illegible] during heating and [illegible] an electrolytic [illegible] character in agreement with [illegible] of the [illegible] resulting from [illegible] [illegible]

62

1

Methods of [illegible] of the amounts of [illegible] [illegible] phases [illegible]

[illegible]

W. M. Sternberg

USSR / Solid State Physics / Phase Tra... mations in Solid Bodies E-6

Abs Jour : Ref Zhur - Fizika, No. 5, 1957 No. 11698

Author : Apayev, B.A.
Inst : -
Title : On the Determination of the Amount of Austenite by Magnetic Method.

Orig Pub : Zavod. laboratoruja, 1956, 22, No. 6, 752 - 755

Abstract : Remarks to an article by Yu. A. Geller (Referat Zhur Fizika, 1955, 24562). The answer by Geller and additional remarks by the author are also given.

Card: 1/1

Category : USSR/Solid State Physics - Phase transformation of solid bodies E-5

Abs Jour : Ref Zhur - Fizika, No 1, 1957, No 1225

Author : Apayev, B.A.
Inst : Gor'kiy Univ. USSR
Title : Carbide Phases Formed Upon Tempering of Hardened Steel

Orig Pub : Dokl. AN SSSR, 1956, 107, no 5, 685-688

Abstract : Carbide phases of iron Fe_3C, χ Fe_2C, and $\mathcal{E}$ Fe_2C, with Curie points of 210, 265 and 380°, were observed by the investigators during the synthesis of hydrocarbons of CO and H_2 in a study of carbide formation in iron catalyzers. The transformation in such phases can be represented by $\mathcal{E}\ Fe_2C \rightarrow \chi\ Fe_2C \rightarrow Fe_3C$. An investigation of the carbide formation during annealing of hardened carbon steel shows that carbide phases, characterized by the same values of Curie points, are formed at definite stages of the annealing. The first two phases are designated by the author $\mathcal{E}$ Fe_xC, there being a difference of opinion concerning the chemical composition of these phases. The decomposition products of these phases and their temperature stability turn out to be the same as in the $\mathcal{E}$ and χ phases, formed during synthesis of hydrocarbons with an iron catalyzer. The carbide-formation process in metal and high carbon steels (U6 -- U12) is given by the following scheme: $Fe\ \alpha\ (C) \rightarrow \mathcal{E} Fe_xC \rightarrow Fe_x \rightarrow Fe_3C$.

Card : 1/1

ARAVEV, R. A.

USSR/Magnetism - Ferromagnetism F-2

Abs Jour : Ref Zhur - Fizika, No 1, 1958, 1135

Author : Apayev, B.A.

Inst : Gor'kiy University

Title : Concerning the Problem of the Magnetic Effect on the Curves $I_s(t^0)$ in the Temperature Range 260 -- 270°, Obtained for Tempered and Deformed Specimens.

Orig Pub : Fiz. metallov i metallovedeniye, 1957, 4, No 2, 267-277

Abstract : In the tempering of hardened steel and in the deformation of annealed steel, there is observed an identical character of the variation of the magnetic properties, namely an increase in the magnetization (compared with the magnetization in the annealed state) and the appearance of a bend in the curves $I_s(t^0)$ in the region from 260 to 270° (in addition to the bend at the Curie point of the

Card 1/2

AUTHOR: Apayev, B. A., Candidate of Technical Sciences.

129-7-5/16

TITLE: On the mechanism of carbide formation during tempering of carbon steel. (O skhemakh karbidoobrazovaniya pri otpuske uglerodistoy stali).

PERIODICAL: "Metallovedenie i Obrabotka Metallov" (Metallurgy and Metal Treatment), 1957, No.7, pp.23-24 (U.S.S.R.)

ABSTRACT: Prof. A. P. Gulyaev suggested that the schemes of carbide formation should be represented in the form of a diagram of the temperature regions of stability of the carbide phases. Such a diagram enables for a given composition of the steel to follow the change in the phase composition in the case of gradual increase in the tempering temperature. The position of the lines in this diagram depends on the duration of the tempering or on the speed of heating and, therefore, the diagram has to be plotted for such conditions that the tempering regime is maintained equal for all the investigated specimens. With increasing duration of the tempering or with decreasing heating speeds all the lines of the diagram will become displaced towards lower temperatures but the displacement will not be equal for all the lines nor for all the sections of the individual lines. Such a diagram is drawn (p.24) and

Card 1/2

32-7-19/49

AUTHORS: Tolomasov, V.A., Apayev, B.A.

TITLE: Discussion of the Measuring Scheme of the Ballistic Magnetometer and Anisometer
(Issledovaniye izmeritel'nykh skhem ballisticheskogo magnitometra i anizometra)

PERIODICAL: Zavodskaya Laboratoriya, 1957, Vol. 23, Nr 7, pp. 821 - 825 (USSR)

ABSTRACT: This paper discusses the effective ratio between the recordings obtained from the apparatus and the actual degree of magnetization for the ballistic magnetometer and anisometer. By means of computation possible errors are discussed on the basis of certain conditions and corresponding corrections are described. The paper consists of two parts: 1.) Ballistic magnetometer. The principle of the construction of the latter is based upon measuring of the magnetic current in the coil, which is generated during the removal of the sample located between the two magnetic poles (through a corresponding channel); this is also accompanied by a nonuniform magnetization of the sample during this process. (Examples are given). In paragraph 2.) Magnetometer with dipole measuring scheme (anisometer) the construction of the apparatus mentioned is des-

Card 1/2

AUTHORS: Apayev, B. A., Sysuyev, Yu. A. SOV/163 -58-2-38/46

TITLE: The Changes in Cementite Caused by Cold Plastic Deformation (Izmeneniya v tsementite pod deystviyem kholodnoy plasticheskoy deformatsii)

PERIODICAL: Nauchnyye doklady vysshey shkoly. Metallurgiya, 1958, Nr 2, pp. 209 - 213 (USSR)

ABSTRACT: The increase of magnetization in iron-carbon alloys at temperatures above 270°C as a result of the deformation and the increase of the α-solid solution quantity. The investigations were carried out with steel samples of the type 45 in hardened and annealed state. The increase of the magnetism may also be caused by the phase χ-Fe_xC. The change of the magnetism in the steel samples 45 and U-10 was investigated as dependent on the degree of deformation. When comparing the curves plotted with one another a quantitative relation between the carbon of the steel and the amount of the χ-Fe_xC-phase formed was found. The course of the phase transformation in cementite under the effect of cold deformation shows that it is

Card 1/2

The Changes in Cementite Caused by Cold Plastic Deformation SOV/163-58-2-36/46

necessary to take into account this phenomenon when investigating the mechanical properties as well as the mechanism of the plastic deformation in heterogeneous systems. There are 4 figures and 12 references, 6 of which are Soviet.

ASSOCIATION: Issledovatel'skiy fiziko-tekhnicheskiy institut Gor'kovskogo gos.universiteta (Physico-Technical Research Institute of Gor'kiy State University)

SUBMITTED: October 1, 1957

Card 2/2

TIKHONOV, G.F., kand. tekhn. nauk, dots.; APAYEV, B.A., kand. fiz.-mat. nauk; RUNOV, V.V., inzh.

Investigating the graphitization of white cast iron by means of the magnetic method. Izv. vys. ucheb. zav.; chern. met. no.4: 147-152 Ap '58. (MIRA 11:6)

1. Gor'kovskiy politekhnicheskiy institut i Gor'kovskiy fiziko-tekhnicheskiy institut.

(Cast iron--Metallography)

(Ferromagnetism)

AUTHOR: Apayev, B.A. SOV/126-6-5-15/43

TITLE: Processes of Carbide Formation During Tempering of Chromium Steel (Protsessy karbidoobrazovaniya pri otpuske khromistykh staley)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1958, Vol 6, Nr 5, pp 858 - 865 (USSR)

ABSTRACT: The difference in behaviour between alloy steels and carbon steels during tempering is that not only carbon, but also the alloy elements redistribute themselves between the α-solid solution and the carbide phases. Various mechanisms for carbide formation on tempering have been suggested (Refs 1-6). The authors of papers (Refs 2-6) think that the chromium content of the first portions of cementite forming is the same as the average chromium content of the steel. Hence chromium takes part in the formation of carbides from the commencement of tempering:. Lashko et al (Ref 7) think that the changes on tempering become more complex as the alloy element content increases. A metastable face-centred cubic γ'-phase in alloys containing 10 to 15% Cr forms first and

Card1/6

SOV/126-6-5-15/43

is followed by trigonal carbide formation. The γ'-phase is thought to be similar in chemical composition to trigonal carbide. The crystallisation of cubic carbide, as well as of trigonal, takes place from the α-solid solution after $(Cr,Fe)_7C_3$ has gone into solution. In a number of papers (Refs 3,4,8 and 9) the formation of a low-temperature phase Fe_xC during tempering of chromium steels is mentioned. The chemical composition of the steels investigated by the author of the present paper is given in Table 1. All steels were quenched from specified temperatures above 1 000 °C, into 10% caustic soda solution, followed by cooling in liquid oxygen. High carbon chromium steels (Cr/C = 3-7) were given a homogenising anneal in vacuum at 1 200 °C for 12 hours prior to quenching. The investigation was carried out on a magnetometer in a field of 7 000 Oe, the specimens being cylinders of 4 mm dia and 40 mm length. Conclusions as to the formation of ferromagnetic phases were arrived at on the basis of $I_s(t)$ curves, which were plotted for the specimens during repeated heating after the above heat

SOV/126-6-5-15/43

Processes of Carbide Formation During Tempering of Chromium Steel

treatment. The change in phase composition with length of tempering time or with increase in tempering temperature was determined by comparing the appropriate repeated heating curves. The behaviour of the steel 10Kh15 is shown graphically in Figures 1, 2 and 3 and of steels 10Kh30 in Figures 4 and 5. The solution of chromium in cementite can be observed in the magnetic analysis by the displacement of the A_0 point. The dependence of the value of the Curie point of cementite on tempering temperature is shown in Figure 6. From the curves it follows that, commencing from a certain definite temperature for each steel, the Curie point is displaced towards lower temperatures. The temperature at which chromium begins to dissolve in cementite decreases with increasing chromium content of the steel. Also from Figure 6 can be concluded that the cementite phase forming initially during continuous heating of steel does not contain any chromium. The solution of chromium in cementite always precedes the formation of special chromium carbides. The formation of trigonal carbide takes place when the limiting concentration

Card3/6

of chromium in cementite (13 to 25%) is reached and is independent of the chromium content of the steel. The temperature at which this preliminary stage is complete can be assumed to be also the temperature at which the special carbides begin to form. Both these temperatures must depend in the same way on the relative concentration, dropping with increase in the value of Cr/C. As the limiting concentration of chromium in cementite is obtained, the latter becomes paramagnetic. The beginning of trigonal carbide formation in the magnetic analysis is the temperature at which the A_0 point appears in the $I_s(t)$ curves.

A comparison of these temperatures with the special carbide formation temperature, according to the results of investigation by Bokshteyn (Ref 2) confirms such an interpretation (see Table 2). The carbide formation in chromium steel on tempering can be checked very simply from temperature-relative concentration of alloy element (Cr/C) diagrams. Such a diagram, in which the temperature range at which the carbide phases of chromium steels (at a constant C content of 1%) remains stable during tempering is shown in Figure 7. Up to a relative Cr/C concentration of <3 all three carbide phases of iron form during tempering. For compositions in which the formation of trigonal carbide is possible, the change in phase composition with increase in tempering temperature will go through the stages

$$M \rightarrow \varepsilon \rightarrow \chi \rightarrow Fe_3C \rightarrow (Fe,Cr)_3C \rightarrow [(Fe,Cr')_3C + (Cr,Fe)_7C_2] .$$

At relative Cr/C concentrations of >3, two iron carbide phases form, $\varepsilon - Fe_xC$ and Fe_3C. The change in phase composition with increase in tempering temperature in these two stages may be represented by:

$$M \rightarrow \varepsilon \rightarrow [\varepsilon + Fe_3C] \rightarrow [\varepsilon + (Fe,Cr)_3C] \rightarrow (Fe,Cr')_3C \rightarrow$$

$$\rightarrow [(Fe,Cr'')_3C + (Cr,Fe)_7C_3] .$$

As the chromium content of steel is increased, the temperature of decomposition of residual austenite increases.

SOV/126-6-5-15/43

Processes of Carbide Formation During Tempering of Chromium Steel

At a value of Cr/C > 8, chromium steels belong to the austenitic class. The investigation carried out has shown that a universal scheme for the description of tempering processes applying to all steel compositions cannot be established.

There are 7 figures, 2 tables and 13 Soviet references.

ASSOCIATION: Gor'kovskiy issledovatel'skiy fiziko-tekhnicheskiy institut (Gor'kiy Physico-technical Research Institute)

SUBMITTED: March 18, 1957

Card 6/6

APAYEV, B.A., kand.fiz.-matem.nauk, red.; ASTROV, Ye.I., kand.tekhn. nauk, red.; KNYAZEV, V.V., red.; BRULIKOVSKAYA, R.G., tekhn.red.

[Metallography and the heat treatment of metals; collection of articles] Metallovedenie i termicheskaia obrabotka; sbornik statei. Gor'kii, Gor'kovskoe knizhnoe izd-vo, 1959. 184 p. (MIRA 13:2)

1. Gor'kovskiy issledovatel'skiy fiziko-tekhnicheskiy institut (for Apayev). 2. Gor'kovskiy metallurgicheskiy zavod (for Astrov).

(Metallography) (Metals--Heat treatment)

PHASE I BOOK EXPLOITATION SOV/3559

Akademiya nauk SSSR. Institut metallurgii. Nauchnyy sovet po probleme zharoprochnykh splavov

Issledovaniya po zharoprochnym splavam, t. 5 (Investigations of Heat-Resistant Alloys, Vol 5) Moscow, Izd-vo AN SSSR, 1959. 423 p. Errata slip inserted. 2,000 copies printed.

Ed. of Publishing House: V.A. Klimov; Tech. Ed.: I.F. Kuz'min; Editorial Board: I.P. Bardin, Academician, G.V. Kurdyumov, Academician, N.V. Ageyev, Corresponding Member, USSR Academy of Sciences (Resp. Ed.), I.A. Oding, I.M. Pavlov, and I.F. Zudin, Candidate of Technical Sciences.

PURPOSE: This book is intended for metallurgical engineers, research workers in metallurgy, and may also be of interest to students of advanced courses in metallurgy.

COVERAGE: This book, consisting of a number of papers, deals with the properties of heat-resisting metals and alloys. Each of the papers is devoted to the study of the factors which affect the properties and behavior of metals. The effects of various elements such as Cr, Mo, and V on the heat-resisting properties of various alloys are studied. Deformability and workability of certain metals as related to the thermal conditions are the object of another study described. The problems of hydrogen embrittlement, diffusion and the deposition of ceramic coatings on metal surfaces by means of electrophoresis are examined. One paper describes the apparatus and methods used for growing monocrystals of metals. Boron-base metals are critically examined and evaluated. Results are given of studies of interatomic bonds and the behavior of atoms in metal. Tests of turbine and compressor blades are described. No personalities are mentioned. References accompany most of the articles.

APAYEV, B. A.

[redacted]

The third prize(imeni D. K. Chernov) was awarded to the following: Candidate of Physico-Mathematical Sciences B. A. Apayev (Gor'kiy Physico-Technical Research Institute) for his paper "Investigation of Processes During Tempering of Hardened Steel".

Results of the 1958 Competition for Obtaining imeni D. K. Chernov and imeni N. A. Minkevich Prizes, Metallovedeniye i termicheskaya obrabotka metallov, 1959, No. 6, pp 62-64

36604
S/137/62/000/004/088/201
A052/A101

18.7500

AUTHOR: Apayev, B. A.

TITLE: Redistribution of carbon and alloying elements at tempering hardened steels

PERIODICAL: Referativnyy zhurnal, Metallurgiya, no. 4, 1962, 14 - 15, abstract 4I92 (V sb. "Metallovedeniye i term. obrabotka". Gor'kiy, 1959, 103 - 116)

TEXT: The following mechanism of redistribution of C and alloying elements at tempering the martensite hardened steels is discussed. In straight carbon steels containing $< 0.4\%$ C the carbide formation proceeds by the scheme $M \rightarrow \varepsilon Fe_xC \rightarrow Fe_3C$, and at C content of $> 0.4\%$ by the scheme $M \rightarrow \varepsilon Fe_xC \rightarrow \chi Fe_xC \rightarrow Fe_3C$. The alloying elements change the temperature precipitation boundaries of these carbides, whereby with an increased metal-to-C ratio the degeneration of χ-carbide takes place. In steels with Mo, V, W insoluble in Fe_3C, the stages of redistribution of C and alloying elements are separated from one another and proceed one after another until the moment of the special carbide formation, taking place at the Fe_3C - ferrite boundaries. The latter stage is preceded by

Card 1/2

S/137/61/000/012/135/149
A006/A101

AUTHORS: Apayev, B.A., Krasotskaya, S.N.

TITLE: An experimental method of calculating magnetization of carbon steel martensite

PERIODICAL: Referativnyy zhurnal. Metallurgiya, no. 12, 1961, 39, abstract 12I306 (V sb. "Metallovedeniye i term. obrabotka", Gor'kiy, 1959, 130 - 136)

TEXT: An experimental method is proposed to determine magnetization of a martensite standard from the effect of reducing the magnetization of a quench-hardened specimen at the initial stages of its low-temperature tempering. It is assumed that for a certain moment of the low-temperature tempering (100-200°C) only martensite is the source of carbide phases, whose singling-out reduces magnetization. Therefore the decrease of magnetization observed is proportional to the volumetric martensite percentage in the specimen. This indicates the possibility of using conventionally quench-hardened specimens to obtain tempered martensite standards. The material investigated was carbon steel, containing from 0.4 to 1.2% C. It is shown that the magnitude of maximum magnetization

Card 1/2

reduction, as a function of the C percentage, was practically equal for all tempering temperatures, but the rate of martensite decomposition increased with higher temperatures. It is shown that the nature of preliminary quenching has no marked effect on the content of residual austenite after processing in liquid O. Data on the percentage of residual austenite are in agreement with results obtained by Roberts who employed a precision roentgenostructural method. There are 12 references.

I. Nikitina

[Abstracter's note: Complete transl ion]

AUTHORS: Apayev, B.A. (Cand.Phys.Mat. Sciences), SOV/129-59-6-1/15
Krasotskaya, S.N. and Makarychev, V.N. (Engineers)

TITLE: On the Correspondence of the Kinetics of Decomposition of Residual and Supercooled Austenite in Alloy Steels (O sootvetstvii kinetik raspada ostatochnogo i pereokhlazhdennogo austenita v legirovannykh stalyakh)

PERIODICAL: Metallovedeniye i termicheskaya obrabotka metallov, 1959, Nr 6, pp 2-6 (USSR)

ABSTRACT: The aim of the work described in this paper was to obtain comparative data on the kinetics of decomposition of residual and supercooled austenite, and also to elucidate the influence of the speed of heating on the decomposition of residual austenite during tempering for a large number of alloy steels (Refs 1-6). The investigations were carried out on tungsten, vanadium, chromium and molybdenum steels, for which the contents of carbon and of alloying elements and also of the residual austenite, are entered in Table 1, page 2. After preliminary homogenization annealing at 1200 °C for 6 hours, specimens of 4 mm dia and 40 mm length were quenched in oil. The process of isothermal decomposition of residual austenite was studied

at the tempering temperatures 300 to 650 °C, in steps of 50°C, with holding times at each temperature of 60 minutes in molten tin. The investigations were carried out magnetically by means of a MAG 51 instrument which enabled following phase changes in the specimen from the instant of charging it into the bath up to the end of holding it at the given temperature, and also during subsequent cooling. For each tempering temperature a decomposition isotherm was recorded in coordinates of instrument readings (α) versus time (τ). For each temperature the time of heating the specimen through to the bath temperature, i.e. the non-isothermal range of the process, was evaluated from the time taken from the instant of charging the annealed specimen into the bath up to the instant of termination of changes in the magnetization values. For bath temperatures between 300 and 650 °C the heating time varied between 5 and 12 seconds. The decomposition of supercooled austenite was studied in the temperature range 300 to 700 °C, whereby the heating temperature for quenching was 1100 °C for

On the Correspondence of the Kinetics of Decomposition of Residual and Supercooled Austenite in Alloy Steels

all the tested steels; liquid tin served as the isothermal medium. The results confirm that Mo, W and V, have little influence on the stability of residual austenite for a wide range of concentration of these alloying elements (up to 18% W up to 4% V, up to 2% Mo). No increase in the stability of the austenite was observed in chromium steels with up to 4% Cr. Diagrams of transformation of the residual and supercooled austenite for several of the tested steels are reproduced in Figs 1 - 5. It was found that the kinetics of transformation of the residual austenite and the influence of alloying elements on this process depend on the tempering conditions. For a number of steels the alloying elements did not have any considerable influence on the stability of the austenite in the case of slow heating. High heating speeds bring about a rapid change in the kinetics of decomposition of the residual austenite and it becomes comparable in character with the kinetics of isothermal transformation of supercooled austenite. Comparison of the decomposition diagrams

SOV/129-59-6-1/15

On the Correspondence of the Kinetics of Decomposition of Residual and Supercooled Austenite in Alloy Steels

allows the conclusion that the complicated shape of the transformation diagram of residual austenite was observed, in all the investigated steels, for contents of the alloying element which were considerably higher than in the case of supercooled austenite. This may be due to the fact that for the given volume of the specimen it was not possible to achieve isothermal conditions of tempering. In the case of specimens of smaller volumes, better correspondence can be anticipated between the individual diagrams. The zones of stability of residual and supercooled austenite were either the same for all the investigated steels, or the zone of stability of residual austenite was at lower temperatures. The diagrams of decomposition of residual austenite are particularly important when working out regimes of tempering of high alloy case-hardened steels, and also when working out tempering regimes in molten salts or metals. The results obtained by the authors of this paper indicate that the speed of heating during tempering may in some cases be of considerable importance. An

Card4/5

SOV/129-59-6-1/15

On the Correspondence of the Kinetics of Decomposition of Residual and Supercooled Austenite in Alloy Steels

identical tempering regime may lead to different results if the heating is effected at differing speeds. Whilst in the case of slow heating the transformation is fully terminated during the process of holding at a certain temperature, during rapid heating the transformation may also proceed during the cooling. In view of the fact that for a wide range of steels the character of the kinetics of transformation of residual and supercooled austenite is similar (provided the isothermal nature of the process is conserved), there is a possibility of evolving a unified theory of the processes involved. There are 5 figures, 2 tables and 11 references, 10 of which are Soviet and 1 English.

ASSOCIATION: Gor'kovskiy issledovatel'skiy fiziko-tekhnicheskiy institut (Gor'kiy Physico-technical Research Institute)

Card 5/5

AFAYEV, B.A., kand. fiz.-mat.nauk; KRASOTSKAYA, S.N., inzh.; YAKOVLEV, B., inzh.

Effect of alloy elements on the stability of martensite during low-temperature tempering. Izv. vys. ucheb. zav.; chern. met. 2 no.4:89-92 Ap '59. (MIRA 12:8)

1. Gor'kovskiy issledovatel'skiy fiziko-tekhnicheskiy institut. Rekomendovano Uchenym sovetom Gor'kovskogo issledovatel'skogo fiziko-tekhnicheskogo instituta.
(Steel alloys--Metallography) (Tempering)

APAYEV, B.A., dotsent, kand.fiz.-mat.nauk

Process of carbide formation during the tempering of molybdenum and manganese steels. Izv.vys.ucheb.zav.; chern.met. 2 no.5:73-82 My '59. (MIRA 12:9)

1. Gor'kovskiy issledovatel'skiy fiziko-tekhnicheskiy institut. Rekomendovano Uchenym sovetom Gor'kovskogo issledovatel'skogo fiziko-tekhnicheskogo instituta.
(Steel--Heat treatment) (Phase rule and equilibrium)

APAYEV, B.A., inzh.

Effect of alloying elements and carbon on the kinetics of decomposition in undercooled austenite. Izv.vys.ucheb.zav.; chern.met. 2 no.10:113-129 O '59. (MIRA 13:3)

1. Gor'kovskiy issledovatel'skiy fiziko-tekhnicheskiy institut.
(Steel alloys--Metallography) (Metals at low temperature)

18(3), 18(7), 24(2)

AUTHORS: Krasotskaya, S. N. and Apayev, B. A. SOV/126-7-2-6/39

TITLE: Decomposition of Residual Austenite in the High-Speed Steel R18 (O raspade ostatochnogo austenita v bystrorezhushchey stali R18)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1959, Vol 7, Nr 2, pp 192-197 (USSR)

ABSTRACT: Residual austenite in high speed-steel decomposes on cooling after soaking at 500 to 560°C whereas in carbon and alloy steels this happens on heating. The steel R18 represents a complex system, hence it was appropriate to investigate the behaviour on tempering of the super-cooled γ-phase of simpler systems, namely, the binaries Fe-W, Fe-V and Fe-Cr; the ternaries Fe-C-W, Fe-C-V and Fe-C-Cr, and the quaternary Fe-W-V-Cr. No change in the magnetic properties of the ferrites, including the complex alloy one, were observed. This means that the presence of residual austenite is associated with carbon content. For the study of the decomposition of residual austenite in quenched steels, $I_s(t^o)$ curves were plotted for specimens during continuous heating up to 650°C and subsequent cooling in a magnetometer furnace. The

Card 1/6

APPROVED FOR RELEASE: 06/19/2000 CIA-RDP86-00513R000101820016-2"

SOV/126-7-2-6/39

Decomposition of Residual Austenite in the High-Speed Steel R18

heating and cooling rate was $5^{\circ}C/min$. Such curves are shown in Fig 1a for tungsten steels with limiting W contents (1 and 18%); in Fig 1b for vanadium steels (0.3 and 4% V); and in Fig 1B for chromium steels (4 and 8% Cr). An investigation of three systems in a concentration range corresponding to the alloy element content of the steel R18 has shown that the decomposition of residual austenite takes place during heating, being complete at 375 to $400^{\circ}C$. As the W, V and Cr content is increased, the stability of the residual austenite tends to increase. From the $I_s(t^{\circ})$ curves plotted in the same way for the steel R18 it can be seen that the bulk of the austenite of this steel decomposes on cooling. However, if the heating rate is reduced to $0.3^{\circ}C/min$, the decomposition of the residual austenite occurs in the same manner as in the other steels, i.e. during heating, but at higher temperatures (625 to $675^{\circ}C$, see Fig 2). Whereas the behaviour of 8% Cr steel is similar to that of the steel R18 (see Figs 3a,b and 4a,b), that of the others investigated is different, the austenite decomposes on

Card 2/6

heating and during isothermal soaking but not on cooling. This might lead to the assumption that the characteristic of decomposition of the γ-phase in high-speed steel is associated with the presence of chromium. However, austenite of the steel R18 contains only 8% Cr. This suggests that a characteristic of austenite decomposition may be due not to the absolute chromium content but to its relative concentration, i.e. the Cr/C ratio which, according to Michel and Papier (Ref 2), is 9 for steel R18. Confirmatory experiments with other steels (0.2 and 0.5% C and 4% Cr) have shown that the decomposition of residual austenite occurs only during heating and isothermal soaking. The results obtained led to the conclusion that the stability of austenite in the steel R18 during heating is due to the joint action of carbon and alloy elements. The stability of the γ-phase during isothermal soaking at the tempering temperature range of this steel may be associated with this. A study of the nature of decomposition of super-cooled austenite of W-, V-, and Cr-steels has shown that, as the alloy element content of 1% carbon steel is increased, the isothermal decomposition diagrams gradually change from the usual (C-shaped) to the more complex (S-shaped) ones and the temperature range of austenite stability widens. This zone becomes clearly pronounced in W-steels at a W content $\geq$ 6%, and V- and Cr-steels at a content of $\geq$ 2% of these elements respectively. Figs 5 and 6 show the change in magnetization in steels 10X40 and 10W60 respectively - 1) on isothermal soaking and 2) on repeated heating and cooling. In all the investigated steels having a zone in which the supercooled austenite is stable, the austenite is also stable in the range 500 to 550 °C. If the transformation in the isothermal soaking range does not go to full completion, then decomposition of austenite (residual and supercooled) occurs during cooling. The relationship between the stability zone temperatures and kinetics of decomposition permit the conclusion that the stability of austenite and the nature of processes occuring on tempering quenched steels and isothermal decomposition of supercooled austenite are due to some common reasons which so far have not been elucidated. A comparison of the

SOV/126-7-2-6/39

Decomposition of Residual Austenite in the High-Speed Steel R18

kinetics of decomposition of residual asutenite on tempering the steel R18 and steels containing the same quantity of alloy elements as high-speed steel shows that on alloying the steel with W and Cr the decomposition of austenite proceeds analogously to the decomposition of austenite in steel R18. Alloying with V does not lead to the same analogy. This leads to the conclusion that the characteristics of decomposition of austenite of high-speed steel is associated with the action of Cr and W. Cr tends to raise the stability of residual austenite considerably. The complete similarity in the kinetics of austenite decomposition of high-chromium steels and steel R18 on isothermal tempering leads to the conclusion that chromium exercises the strongest influence.

There are 6 figures and 5 references, 4 of which are Soviet, 1 French.

ASSOCIATION: Issledovatel'skiy fiziko-tekhnicheskiy institut pri Gor'kovskom gosudarstvennom universitete (Physico-Technical Research Institute of the Gor'kiy

Card 5/6

SOV/126-7-2-6/39

Decomposition of Residual Austenite in the High-Speed Steel R18

State University)

SUBMITTED: June 11, 1957

Card 6/6

18.7500

67672
SOV/126-8-6-20/24

AUTHORS: Apayev, B.A. and Sysuyev, Yu.A.

TITLE: Influence of the Original Structure and Temperature of Deformation on Phase Transformations During Plastic Deformation

PERIODICAL: Fizika metallov i metallovedeniye, 1959, Vol 8, Nr 6, pp 915-921 (USSR)

ABSTRACT: This paper is devoted to questions similar to those published earlier (Ref 11 and 12) and also to the study of the influence of the deformation temperature and original structure on the nature of phase transformations and hardening during deformation. The production types of steel U12 and U10 were used as materials for investigation. Prior to deformation, specimens of 4 x 40 mm cross section were subjected to a series of heat treatments, the conditions of which are indicated in Fig 1, in order to obtain structures with different shapes of cementite. Deformation was carried out by universal non-uniform compression in rings (Ref 16). During deformation in a medium of liquid nitrogen, the specimens, compressed in the ring, were preliminarily cooled in nitrogen in a Dewar flask. As soon as the nitrogen was off the boil, they were

Card 1/5

4

APPROVED FOR RELEASE: 06/19/2000 CIA-RDP86-00513R000101820016-2"

67672

SOV/126-8-6-20/24

Influence of the Original Structure and Temperature of Deformation on Phase Transformations During Plastic Deformation

placed in a die accommodated in a retort which was also filled with nitrogen. The retort size was selected so that the specimen should be covered by liquid nitrogen during deformation. Upsetting was carried out in a 60 ton Gagarin press. The degree of deformation (ψ %) was determined according to the change in length of the specimen and was between 25 and 27%. The magnetic phase analysis method was chosen as the method of investigation. Determination of the phase composition was carried out according to magnetographs (curves $J_s(t)$), which were constructed with a ballistic magnetometer in a field of 10,000 oersted. The phase composition of the specimens after the above heat treatments is represented by magnetographs in Fig 1. In Fig 2 magnetographs of the same specimen after deformation at room temperature are illustrated. In order to prevent heating of the specimens in the second series of experiments, the deformation was carried out in liquid nitrogen. It has been found that the nature of the mechanism of deformation is preserved at a temperature of -196°C (Fig 3). In Fig 4, magnetographs

Card 2/5

are shown of the original specimen and of specimens which had been compressed by 46.6 and 86.85% (curves 2, 3 and 4). The magnetograph of the original normalized specimen is represented by curve 1. The increase in the total magnetization of the specimen and in the magnetization in the ferrite portion of the curve $J_s(t)$ (Fig 5) with increase in degree of deformation shows that an ever-increasing quantity of the cementite phase is taken into solution during transformation and that this transformation leads to an increase in the quantity of the α-phase. The curves 1, 2 and 3 in Fig 6 characterize the volume change of ferrite, cementite and χ-carbide, respectively, in relation to degree of deformation. In Fig 7 the change in hardness in relation to degree of deformation is illustrated for steel with granular and plate-like cementite. The work carried out shows that the more distinctly the plate-like shape of cementite is outlined, the more rapidly does its decomposition proceed with formation of χ-carbide and α-iron. As the plate-like form decreases, this process becomes less distinct and

4

67672
SOV/126-8-6-20/24

Influence of the Original Structure and Temperature of Deformation on Phase Transformations During Plastic Deformation

when the cementite acquires a granular shape, this process does not take place at all. In the light of these facts, it must be assumed that steel which has been annealed so as to exhibit granular cementite is more stable than that annealed to give plate-like cementite. Lowering the deformation temperature does not change the general nature of transformation and the relationship with the structure. As long as the carbide phase $\chi Fe_x C$ forming differs in carbon content from cementite, there is a possibility of diffusion processes as the result of deformation at low temperatures. The mechanism of formation of this carbide is not understood. It originates either from austenite formed due to local heating or as the result of a crystallographic rearrangement of cementite under the action of stress. Gratitude is expressed to S.V.Vonsovskiy for his interest in the discussion of preliminary experimental results and for his offer to study the nature of phase transformations during deformation in liquid nitrogen. There are 7 figures and 21 references, 18 of which are Soviet,

Card 4/5

67672

SOV/126-8-6-20/24

Influence of the Original Structure and Temperature of Deformation on Phase Transformations During Plastic Deformation

2 English and 1 Japanese.

ASSOCIATION: Gor'kovskiy issledovatel'skiy fiziko-tekhnicheskiy institut (Gor'kiy Physico-Technical Research Institute)

SUBMITTED: January 1, 1959

Card 5/5

APAYEV, B.A.; SYSUYEV, Yu.A.

Phase transformations during the mechanical testing of ordinary carbon steel. Izv.vys.ucheb.zav.; chern.met. no.5:91-92 '60. (MIRA 13:6)

1. Gor'kovskiy issledovatel'skiy fiziko-tekhnicheskiy institut.
(Steel--Metallography) (Phase rule and equilibrium)

S /139/60/000/005/025/031
E /073/E135

AUTHORS: Sysu'yev, Yu.A., Apayev, B.A., and Balakina, L.M.

TITLE: Investigation of the Phase Composition and of the Fine Crystal Structure of a Plastically Deformed Steel

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Fizika, 1960, No. 5, pp 148-152

TEXT: Since the nature of the transformations in the cementite phase depends on the shape of its particles, it was interesting to elucidate the character of the changes of the fine structure of the α-phase during plastic deformation of steel with cementite particles of various shapes and to what extent the changes in the cementite affect the process of strengthening. Steel У-10 (U 10) was chosen for the investigations after normalisation annealing at 1000 °C and annealing to obtain granular cementite. Specimens of 12 mm dia., 20 mm in length, were deformed to various extents by means of a hydraulic press. To determine the phase composition of the steel after plastic deformation, magnetometric investigations were carried out. From deformed templates specimens were cut (along the diameter) with a length to cross-section ratio equal or larger than 4. From the specimens magnetograms $I_s,(t)$ were plotted by

Card 1/4

S/139/60/000/005/025/031
E073/E135

Investigation of the Phase Composition and of the Fine Crystal Structure of a Plastically Deformed Steel

means of a ballistic circuit magnetometer in fields of 10 000 Oe. For determining the quantitative ratio of the phases the sections of the magnetograms of the phase components were extrapolated to room temperature, using the approximation of Heisenberg (Ref. 12). To detect the nature of the dependence of the stressed state and the crystal structure on the degree of deformation, X-ray measurements were made by means of iron radiation with an ion tube after removing the surface layer by etching. For the investigations the lines (220) of the α-phase and (222) of copper were used. Photometering of all the X-ray diffraction patterns was effected by means of a microphotometer with an amplification of 9 X. The results show that plastic deformation of steels with lamellar and granular cementite leads to differing results. The basic difference consists in the fact that phase transformations are caused in steel with lamellar cementite, whilst in the case of granular cementite this has not been observed. The character of the changes of the fine structure as a result of plastic deformation of steel U 10 in both states is qualitatively equal.

Card 2/4

S/139/60/000/005/025/031
E073/E135

Investigation of the Phase Composition and of the Fine Crystal Structure of a Plastically Deformed Steel

A high level of type II distortions and the smaller size of blocks in the normalized steel can probably be explained by a change in the coherent bond between the α-phase and the cementite as a result of phase reconstruction in the latter. In a number of papers, the change in strength is attributed to changes in the fine structure of the phase components. On the example of single phase systems and satisfactorily annealed multiphase alloys, changes in type II stresses and in the size of blocks have indeed been found to determine the strengthening during plastic deformation (Refs 4, 16, 17). The experimental data given in the present paper indicate that this analogy also applies to steel with granular cementite. Since during deformation of such structures the cementite phase is not subjected to any changes, the changes in hardness can only be due to the state of the α-phase. The higher hardness of the normalised steel both in the initial state and after plastic deformation can also be attributed to the difference in the fine structure. The change in the fine structure is similar for both states of the steel;

Card 3/4

S/139/60/000/005/025/031
E073/E135

Investigation of the Phase Composition and of the Fine Crystal Structure of a Plastically Deformed Steel

however, the character of the strengthening differs. This indicates that the changes in the fine structure of the α-phase do not reflect the law of strengthening during plastic deformation of steel with lamellar cementite.
There are 5 figures and 17 references: 11 Soviet, 5 English and 1 Japanese.

ASSOCIATION: Issledovatel'skiy fiziko-tekhnicheskiy institut Gor'kovskogo gosuniversiteta imeni N.I. Lobachevskogo (Physics and Engineering Research Institute, Gor'kiy State University imeni N.I. Lobachevskiy)

SUBMITTED: December 19, 1959

Card 4/4

69692

S/126/60/009/03/015/033
E111/E452

18.7500

AUTHOR: Apayev, B.A.

TITLE: Contribution on the Contradictions Which Have Arisen About the Carbide Phases Formed in Tempering Carbon Steel

PERIODICAL: Fizika metallov i metallovedeniye, 1960, Vol 9, Nr 3, pp 400-414 (USSR)

ABSTRACT: The author points out that carbide-formation in the iron-carbon system is of interest both in organic chemistry (hydrocarbon syntheses from carbon monoxide and hydrogen on iron catalysts) in case hardening and in the metallurgy of tempering. In organic chemistry the formation of three carbides is generally admitted, controversy centering on the role of the ε and χ carbides in hydrocarbon syntheses (Ref 2,7). However, in the other fields controversy is wider. The author surveys two schools of thought, based on electron and X-ray diffraction analysis. The first (Ref 8 to 17) consider that in tempering two carbide phases, ε-carbide and cementite are produced; the second school (Ref 18 to 21) consider that the phases are a series of

Card 1/4

69692
S/126/60/009/03/015/033
E111/E452

Contribution on the Contradictions Which Have Arisen About the Carbide Phases Formed in Tempering Carbon Steel

carbides isomorphous only with cementite. When magnetic analysis has been used, the carbides revealed coincide with those agreed on in the organic-chemistry field (Ref 3, 25, 26, 33, 34). The author discusses the basis and advantages of magnetic phase analyses which are not appreciated by all workers in this field. He goes on to present some experimental data which indicate the formation of a high-temperature χ-carbide in the tempering of carbon steel. Fig 1 gives saturation-magnetization as functions of temperature for U-10 steel after annealing and tempering at 350 to 650°C. Fig 2 shows the corresponding functions for 25 to 350°C for specimens retempered at higher temperatures (350 to 650°). These results, the author shows, contradict the views of K.Jack (Ref 8) and others (Ref 18,19) involving cementite in the strained state with a Curie point of about 265°C. Further evidence against this view is provided by a check based on Heissenberg's approximation (Ref 52-53). Fig 3 shows the result of such a check for a specimen

Card 2/4

69692
S/126/60/009/03/015/033
E111/E452

Contribution on the Contradictions Which Have Arisen About the Carbide Phases Formed in Tempering Carbon Steel

after 10 hours tempering at 350°C, showing experimental and calculated points for saturation magnetization versus temperature curves. The author cites other experimental evidence, against Jack's views, for example, the effect on saturation-magnetization versus temperature curves of alloying elements (Fig 5), of different heat treatments (Fig 6) and of both these factors (Fig 7), and refers to a previous article of his on this subject (Ref 31). The author's general conclusions from his survey are that magnetic analysis is as objective a method of phase analysis as X-ray methods and can give qualitative and quantitative results for complex systems; a particular advantage is that the Curie points, taken as phase characteristics, are independent of strain and dispersion. Magnetic analysis confirms the existence in tempered carbon steels of three carbide phases, Fe_3C, χ Fe_xC and εFe_xC with Curie points of 210, 265 and 380°C respectively. The observed break near 265°C in the saturation magnetization versus temperature curves is due

Card 3/4

Apayev, B.A.

82640

18.7100

S/126/60/010/02/010/020
E111/E352

AUTHORS: Apayev, B.A., Levina, E.I., Krasotskaya, S.N. and Pavel'yeva, A.I.

TITLE: Solubility of Alloying Elements in Cementite

PERIODICAL: Fizika metallov i metallovedeniye, 1960, Vol. 10, No. 2, pp. 245 - 250

TEXT: In this work the solubility of tungsten, vanadium, chromium and manganese in the first portions of cementite produced on tempering of hardened steel was examined. The increase in their solubility with increasing tempering temperature was also studied. Published data (Refs. 10, 11) show that the solubility of alloying elements is considerably less than their contents in steel (Table 1). The present work was carried out with the following steels, all containing 1% C: 10Kh6 (0.6% Cr); 10Kh40 (4% Cr); 10G12 (1.2% Mn); 10F6 (0.6% V); 10F12 (1.2% V); 10V6 (0.6% W) and 10V20 (2% W). Chromium and manganese steels were hardened from 1150, the others from 1280 °C. Tempering was effected at 250-650 °C, specimens tempered at 450 °C being used for chemical investigation (with electrosolution by N.M. Popova's method,(Ref. 10), applying a

Card 1/3

82640

S/126/60/010/02/010/020
E111/E352

Solubility of Alloying Elements in Cementite

a check). One of the authors (Krasotskaya - Ref 15) has shown that in molybdenum, tungsten and vanadium steels cementite is first formed at 100 °C and that after 10 hours at 250 °C martensite decomposition is practically completed. For this group of steels chemical analysis was carried out only on electrolytic residues of the tungsten and vanadium steels tempered at 250 and 450 °C for 10 hours (Table 3 shows the alloying-element content as percentage of steel sample weight). For 10Kh6, 10G12 and 10Kh40 steels the Curie point (Curves 1, 2, 3, respectively) and the alloying element content of the residue (Curves 3, 4, 6, respectively) are plotted against tempering temperatures. The results of this work contradict the ideas of some authors (Refs. 1-5), as shown in Table 4, where chromium contents of steel and residue are shown for a series of chromium steels. Whatever the alloying element, its initial solubility in cementite is far below its content in the steel; the way in which solubility changes with tempering temperature does depend on the nature of the alloying element. The solubility of the alloying elements in cementite governs their distribution (and that of carbon) between the alpha and carbide

Card 2/3

82640
S/126/60/010/02/010/020
E111/E352

Solubility of Alloying Elements in Cementite

phases. With tungsten, vanadium and molybdenum the redistribution of carbon occurs first for most of the range; with others both carbon and alloying elements can move simultaneously and hence the elements can be present in the first portions of cementite. There are 1 figure, 4 tables and 16 references: 14 Soviet, 1 English and 1 Japanese (in English)

ASSOCIATION: Gor'kovskiy issledovatel'skiy fiziko-tekhnicheskiy institut (Gor'kiy Physics-Technical Research Institute)

SUBMITTED: December 23, 1959

Card 3/3

S/126/60/010/004/004/023
E111/E452

AUTHORS: Apayev, B.A. and Yakovlev, B.M.

TITLE: Use of Magnetic Phase Analysis for Separate Determination of Combined and Free Carbon

PERIODICAL: Fizika metallov i metallovedeniye, 1960, Vol.10, No.4, pp.527-533

TEXT: The authors describe the application of the additivity of saturation magnetization in a heterogeneous system to the determination of ferrite and cementite in steel. Fig.1 shows for some carbon steels the magnetization versus temperature curves required if the chemical composition of the sample is not known. These curves refer to annealed types 10, 20, 30, У7(U7), У9 (U9) and У10 (U10) steels. The cementite determination required extrapolation of the ferrite part of the curve and the authors describe a published (Refs. 2,3) method which gives good agreement of experimental and calculated points (dots and crosses respectively, in Fig.1). Fig.2 illustrates this method and Fig.3 another method in which an armco-iron standard is used (circles in Fig.1). Both methods are applicable in principle to all steels with ferromagnetic carbide phases, providing that the alloying-

Card 1/2

S/126/60/010/004/004/023
E111/E452

Use of Magnetic Phase Analysis for Separate Determination of Combined and Free Carbon

element content in the alpha-solid solution is known. The applicability of both extrapolation methods to the steels represented in Fig.1 is shown in Fig.4, giving a volumetric % cementite as a function of free carbon. The authors have used the technique to study graphitization of two malleable irons (respectively 2.45, 2.45% C; 0.58, 0.50% Mn; 1.16, 1.76% Si; 0.12, 0.60% S; 0.078, 0.078% P; no Cr). Fig.5 gives as functions of temperature the percent cementite and its contribution to magnetization. From these the free carbon was found. The good measure of agreement with chemical-analytical results is shown in Table 2. The method is much faster than chemical analysis. There are 5 figures, 2 tables and 6 references: 3 Soviet and 3 English.

ASSOCIATION: Gor'kovskiy issledovatel'skiy fiziko-tekhnicheskiy institut (Gor'Kiy Physics and Engineering Research Institute)

SUBMITTED: December 17, 1959

Card 2/2

APPROVED FOR RELEASE: 06/19/2000 CIA-RDP86-00513R000101820016-2"

S/126/60/010/005/021/030
E111/E452

AUTHORS: Apayev, B.A. and Sysuyev, Yu.A.

TITLE: Influence of Plastic Deformation on Changes in the Phase Composition of Steels Alloyed with Cr and Mn

PERIODICAL: Fizika metallov i metallovedeniye, 1960, Vol.10, No.5, pp.767-771

TEXT: The authors have previously shown (Ref.1,2) that plastic deformation of carbon steels produces transformation of the cementite phase. The object of the present work was to find the results of plastic deformation of alloyed cementite. Types ШХ15 (ShKh15) and 10Г12 (10G12) (1.01% C and 1.11% Mn) steel were used. After suitable heat treatment to give the required alloying of cementite, blanks were rolled on a laboratory mill and made into test pieces 2.4 ± 0.01 mm in diameter and 36 ± 0.1 mm long. Saturation magnetization was measured in a field of 10000 Oersted at temperatures up to 350°C: results for ShKh15 and 10G12 are plotted in the left hand graphs in Fig.1 and 2 respectively for the undeformed, heat treated state; the corresponding plots for the deformed steels being shown in the right-hand graphs. The work shows that plastic deformation of tempered steel alloyed with

Card 1/3

S/126/60/010/005/021/030
E111/E452

Influence of Plastic Deformation on Changes in the Phase Composition of Steels Alloyed with Cr and Mn

chromium and manganese leads to phase-composition changes depending on the initial structure. If this consists of unalloyed cementite and alpha phase the phase change is similar to that in carbon steels (Ref.2): deformation produces redistribution of iron and carbon, giving a new iron carbide. Deformation of alloyed cementite leads to redistribution of chromium and manganese within the cementite phase. Deformation of structures formed by tempering in the narrow temperature range corresponding to initial stages of alloying, or after prolonged tempering at 650°C, does not produce phase composition changes. From Apayev's previous work (Ref.8) the authors conclude that the alloying-element redistribution phase takes place in two stages, this providing an explanation for the different deformation effects obtained. Cementite grain shape can not be a factor. There are 2 figures and 8 references: 7 Soviet and 1 Non-Soviet.

Card 2/3

S/126/60/010/005/021/030
E111/E452

Influence of Plastic Deformation on Changes in the Phase Composition of Steels Alloyed with Cr and Mn

ASSOCIATION: Gor'kovskiy issledovatel'skiy fiziko-tekhnicheskiy institut (Gor'kiy Physical-Technical Research Institute)

SIBMITTED: December 17, 1959

Card 3/3

YAKOVLEV, B.M., APAYEV, B.A.

Vacuum unit for thermal treatment. Zav.lab. 26 no.5:627-628 '60.
(MIRA 13:7)

1. Gor'kovskiy issledovatel'skiy fiziko-tekhnicheskiy institut i Gor'kovskiy politekhnicheskiy institut.
(Vacuum apparatus)

APAYEV, B.A.; KOTKIS, M.A.

Volume changes of the carbide phase in tempering. Izv.vys.ucheb.zav.; fiz. no.1:150-158 '61. (MIRA 14:7)

1. Fiziko-tekhnicheskiy institut pri Gor'kovskom gosudarstvennom universitete imeni N.I.Lobachevskogo.
(Steel—Heat treatment) (Cementite)

S/148/61/000/012/007/009
E193/E383

AUTHORS: Apayev, B.A., Sysuyev, Yu.A. and Balakina, L.M

TITLE: The effect of carbide transformations on the variation of structure and properties of cold-worked and hardened carbon steels during tempering

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Chernaya metallurgiya, no. 12, 1961, 117 - 124

TEXT: Other workers (Ref. 1: V.K. Babich, K.F.Starodubov - IVUZ, Chernaya metallurgiya, 1958, no.2; Ref. 2: A.P.Gulyayev, N.I. Burova - Metallovedeniye i obrabotka metallov, no. 1, 1955) who have studied changes occurring during tempering of steel at temperatures above 300 °C have found that similar changes take place in both cold-worked and hardened specimens. Starting from the assumption that plastic deformation does not bring about any phase transformations, these workers concluded that the changes observed during tempering could not be caused by transformation of the carbide phases. Results of more recent studies of this problem (Ref. 3: B.A. Apayev, FMM, v.4, no.2, 1957; Ref. 4: B.A. Apayev, Yu.A. Sysuyev - Nauchnyye doklady vysshey shkoly,

Card 1/7

S/148/61/000/012/007/009
E193/E383

The effect of ....

Metallurgiya, no. 2, 1958; Ref. 5: B.A. Apayev, Yu.A.Sysuyev, FMM, v.8, no.6, 1959) indicate, however, that this conclusion is not quite correct. It has been found that plastic deformation of steel with lamellar cementite is accompanied by the formation of carbide χFe_2C and by an increase in the proportion of the α-phase; as the proportion of lamellar cementite decreases, the plastic deformation-induced transformation diminishes and ceases completely when granular cementite only is present in a given steel. The behaviour of cold-worked steel during tempering should therefore depend on the form of cementite it contains and the object of the present investigation was to check the validity of this postulate. The experiments were carried out on specimens of steel У10 (U10), annealed under conditions which ensured the formation of granular cementite, normalized (i.e. containing lamellar cementite) and hardened. The annealed and normalized specimens were cold-worked (by forging and drawing) after which both the cold-worked and hardened (quenched) specimens were tempered for 30 min at progressively higher temperatures in the

Card 2/7

300 - 700 °C range. After each tempering operation the constitution of the specimen was determined by a magnetometric method, its coercive force H_c was measured to provide information on the changes in the state of stress, the size of blocks in the α-phase grains was determined and the Rockwell hardness R_A was measured. The results can be summarized as follows. No change in the constitution during tempering was observed in cold-worked specimens of steel containing granular cementite. In contrast, the constitution of cold-worked steel containing lamellar cementite changed during tempering in a manner similar to that observed in hardened specimens. This is demonstrated by the results presented in Fig. 1, where the proportion (p_v, %) of the α-phase (Curves 1), cementite (Curves 2) and χ-carbide (Curves 3) is plotted against the tempering temperature (°C), Curves a and б relating, respectively, to plastically-deformed (50% reduction) and hardened steel specimens. The temperature range at which the transformation of the χ-carbide took place during tempering of cold-worked

steel (with lamellar cementite) depended on the degree of preliminary deformation, being shifted towards the lower temperatures in heavily deformed material. The variation of other properties is illustrated in Fig. 3, where the coercive force (H_c, erg - graph a) and hardness (R_A - graph б) are plotted against the tempering temperature (°C), Curves 1-3 relating, respectively, to hardened specimens, cold-worked steel with lamellar cementite and cold-worked specimens of steel with granular cementite. The results described above confirmed the findings reported in Ref. 1 on the similar nature of changes occurring during annealing in the properties of hardened and cold-worked steel with lamellar cementite and showed that this similarity was absent when the cold-worked specimens contained granular cementite. In the same way, the form of the cementite affected the changes in the width, B, of X-ray diffraction lines of the α-phase as illustrated in Fig. 4, where B(mm) is plotted against the tempering temperature (°C), Curves 1 and 2 relating, respectively, to deformed specimens of steel with lamellar and granular cementite. On the other hand neither the variation in the X-ray diffraction-lines width of the α-phase nor the H_c curve (Fig. 3a) obtained for the cold-worked specimens of steel with granular cementite resembled those obtained for hardened specimens. The cause of these differences and similarities becomes clear if the tempering-induced changes in the constitution of cold-worked and hardened specimens are compared. As can be seen in Figs 1, 3a and 4, anomalous variation in the coercive force and the X-ray diffraction-lines width takes place in the same temperature range in which the χ-carbide undergoes a transformation. In cold-worked steel with granular cementite in which no phase-transformation occurs, no anomalies in the variation of these two properties were observed. Consequently, the changes in the fine structure which occur during tempering at temperatures above 550 °C and which cause anomalous variation of H_c and B in hardened and cold-worked steel with lamellar cementite are associated with the

As a result, the stability of the mosaic structure of the α-phase is destroyed, which leads to the onset of plastic slip in the crystal lattice, causing fragmentation of blocks and/or inhibiting their growth. These processes, in turn, cause a similar variation in the coercive force and similar character of the softening process during tempering. The results of the present investigation are correlated with those obtained by other workers and it is suggested that changes in other properties (intensity of magnetization, specific volume, etc.) are also affected to a greater or lesser extent by the carbide transformation. On the other hand, this does not apply to specific heat, whose variation is more likely associated with the relief of stresses of the second type in the α-phase lattice. There are 7 figures and 23 references: 20 Soviet-bloc and 3 non-Soviet-bloc. The three English-language references mentioned are: Ref. 12: Ocado, Arato - J. Japan Inst.Metals, v.19, no. 2, 1955; Ref. 22: G.I. Taylor, H. Quinney - Proc. Roy. Soc., 1934, 143, 307; Ref. 23: T. Sato - Sci. Rep.Imp. Univers., 1931, 20, 1.

KRASOTSKAYA, S.N.; APAYEV, B.A.; YAKOVLEV, B.

Effect of alloying elements on the kinetics of isothermal decomposition of residual austenite. Izv. vys. ucheb. zav.; chern. met. 4 no.8:100-107 '61. (MIRA 14:9)

1. Gor'kovskiy issledovatel'skiy fiziko-tekhnicheskiy institut.
(Steel alloys--Thermal properties)
(Phase rule and equilibrium)

20214

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S/126/61/011/002/013/025
E193/E483

AUTHORS: Yakovlev, B.M. and Apayev, B.A.

TITLE: Processes Taking Place During Tempering of Nickel Steels

PERIODICAL: Fizika metallov i metallovedeniye, 1961, Vol.11, No.2, pp.261-271

TEXT: The object of the present investigation was to study the effect of the variation of the nickel content on the process of tempering of hardened steels whose composition is given in Table 1. The cylindrical specimens (40 mm long, 4 mm in diameter) were heated in vacuum to 1150°C, quenched in a 10% solution of caustic soda and then cooled in liquid nitrogen. Tempering was carried out in Wood's alloy (up to 250°C), in tin (up to 650°C) or in a vacuum furnace (at temperatures higher than 650°C). The duration of tempering varied from 6 h at elevated temperatures to 250 h at low temperatures. The magnetic phase analysis which was the main experimental technique was supplemented by X-ray, electronographic and carbide analyses. In the first series of experiments, the effect of nickel on the stability of martensite during low-temperature annealing was studied. The results are reproduced in

Card 1/6

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Fig.1a where the increase $\Delta\alpha$ in the proportion of the α-phase against the tempering temperature (°C), the type of steel being indicated by each curve; in the insert (Fig.1b) the proportion of residual austenite (a_{ocm}, %) in quenched specimens is plotted against the nickel content (%). It will be seen that with increasing Ni content, a_{ocm} increased. At low concentrations, nickel accelerated the decomposition of martensite whose stability increased at high Ni concentrations. In the second stage of the investigation, the general character of the process of formation of carbides during tempering of nickel steel was studied. The results showed that the transformation of the carbide phases in Ni steels takes place in the same manner as in carbon steels, i.e.

$$\text{martensite} \rightarrow \varepsilon Fe_xC \rightarrow \chi\, Fe_xC \rightarrow Fe_3C$$

However, an increase in the Ni content of these steels has a marked effect on the stability and on the rate of the decomposition of the intermediate carbide phases. Thus, with increasing Ni content the stability of the ε-phase increases, reaching a maximum at 2% Ni, after which it decreases again. In contrast to the carbide-forming alloying additions, nickel increases stability of the χ-phase at high temperatures. This is best illustrated in Fig.4, where the proportion (P.%) of the χ-phase present in steels 10Н40 (10N40) (curve 1) and 10Н10 (10N10) (curve 2) is plotted against time (h) of tempering at 600°C. The general process of carbide formation in steel 10N40 is illustrated in Fig.5, where the proportion (P_k, vol.%) of the ϵ-phase (curve 1), χ-phase (curve 2) and cementite (curve 3), present in the steel after 1 h tempering, is plotted against the tempering temperature (°C), the broken portions of the curves being tentative only. It will be seen that the ϵ-phase starts to form at the very beginning of the decomposition of martensite and that at temperatures above 200°C the proportion of this phase rapidly decreases with a corresponding increase in the proportion of cementite and the χ-phase. The intermediate χ-phase is stable up to 400°C; the decomposition of this phase brings about an increase in the quantity of martensite and the qualitative characteristics of this process indicate that in the formula Fe_xC of the χ-phase, $x < 3$. In

S/126/61/011/002/013/025
E193/E483

fact, the results of calculations, based on the magnetometric measurements carried out on specimens, treated to contain a maximum proportion of the χ-phase and subsequently annealed to attain full decomposition of this phase showed that the χ-phase is described by the formula Fe_2C. In the next series of experiments, specimens of steel 10N40, heat treated to contain the maximum proportion of the ε-phase, were dissolved electrolytically and the residues, constituting the ε-phase, were examined by electron diffraction. The results agreed with those obtained by other workers (Ref.15 - 29) and indicated that the ε-phase with the Curie point at 380°C has hexagonal crystal lattice. The results of X-ray diffraction analysis of the χ-phase, separated by the electrolytic method, were also in agreement with those obtained by R.H.Jack (Ref.21) and Oketani (Ref.15). The object of the next series of experiments was to study the solubility of nickel in cementite. To this end, specimens of steels 10H7, (10N7), 10N10, 10N40 and 3H40 (3N40) (0.3% C, 4.0% Ni) were tempered at 700°C for 1 to 50 h, after which they were dissolved electrolytically, the undissolved carbide residues having been examined by chemical

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20214

Processes Taking Place ... S/126/61/011/002/013/025
E193/E483

analysis and magnetometric measurements. The results of the chemical analysis showed that the time at the tempering temperature had practically no effect on the Ni content in the carbide residue. The quantitative data on the composition of the residues, reproduced in Table 5 were in agreement with those quoted in the literature (Ref.27, 29-32). Since, however, the residues probably contained a proportion of undissolved α and γ phases, the increase in the Ni content in the residues does not necessarily mean that with increasing Ni content in the steel the Ni content in the cementite also increases. According to the calculations of the present authors, the solubility of Ni in the cementite of steels 10N7, 10N10, 10N40 and 3N40 is 0.0405, 0.0826, 0.188 and 0.243%, respectively. Based on the results of the present investigation, a diagram of the temperature stability of the carbide phases in tempered Ni steels was constructed. The diagram, reproduced in Fig.10, represents a vertical section of a metastable, ternary Fe-Ni-C system at a constant carbon concentration of 1.0%, constructed on the basis of data on the constitution of the alloys after 1h tempering. There are 10 figures, 5 tables and

Card 5/~~10~~ 6

20734

Processes Taking Place ... S/126/61/011/002/013/025
E193/E483

33 references: 21 Soviet and 12 non-Soviet.

ASSOCIATIONS: Gor'kovskiy issledovatel'skiy fiziko-tekhnicheskiy institut (Gor'kiy Physicotechnical Research Institute)
Gor'kovskiy politekhnicheskiy institut
(Gor'kiy Polytechnical Institute)

SUBMITTED: April 25, 1960 (initially)
September 5, 1960 (after revision)

Card 6/10
6

APAYEV, B.A.; YAKOVLEV, B.M.; TIKHONOV, G.F.

Effect of silicon on processes of carbide formation and graphitization during the tempering of hardened steel. Fiz. met. i metalloved. 12 no.2:208-216 Ag '61. (MIRA 14:9)

1. Gor'kovskiy issledovatel'skiy fiziko-tekhnicheskiy institut i Gor'kovskiy politekhnicheskiy institut imeni A.A. Zhdanova.
(Steel—Heat treatment)
(Silicon)

S/126/61/012/003/012/021
E111/E335

AUTHOR: Apayev, B.A.

TITLE: Some physical properties of the high-temperature carbide of iron χFe_xC, formed on tempering and plastic-deforming

PERIODICAL: Fizika metallov i metallovedeniye, v. 12, no. 3, 1961, 409 - 416

TEXT: The author points out that no reliable data exist on the chemical composition of the χ-carbide formed on medium-temperature tempering of high-carbon steel and on plastic-deforming, when cementite is initially lamellar. This is due to methodological difficulties. In the present work magnetic analysis has been used to calculate the composition and magnetization of this phase and, in combination with the apparent weight-loss method, its density. Two series of experiments were carried out. In the first series У11 (U11) and У13 (U13) steels were used. To eliminate the effect of oxidation, heat-treatment (quenching, followed by cooling in liquid nitrogen, followed by tempering) was carried out on 5.5-mm diameter rods,

Card 1/4

from which 4-mm dia. specimens were prepared for density and magnetic measurements. In the second series, normalized type У10 (U10) steel was used, deformed by drawing through dies with a reduction of 55%. From plots of magnetization as a function of temperature, the proportions of total magnetization due, respectively, to cementite, alpha-phase and χ-carbide, and the volume percentage of each phase were calculated; using published values (Ref. 3 - Yur'yev, S.F. **Specific volumes of phases during austenite-martensite transformation. 1950, Metallurgizdat**) values for the densities of cementite and iron, the latter were converted to weight percentages. The density of the carbide phase was found as the ratio of percentage by weight to that by volume multiplied by the average density. The average value for both steels was 6.73 ± 0.15 g/cm^3. The average magnetization of the χ-carbide phase formed on tempering was found to be 875 gauss (accuracy $\pm$ 10%); an armco-iron specimen was used to find, by extrapolation, the value of magnetization in terms of mm of instrument scale at 0° K. The average value of x in Fe_xC

S/126/61/012/003/012/021
E111/E335

Some physical properties of ....

for U11 steel, tempered at 300 and 350 °C and for U13 steel were found to be 2.07, 1.84 and 2.02 when using a method based on the carbon content of different phases. Witha a method based, in effect, on iron contents, the first value was only 1.63, the other two being in good agreement; this discrepancy is probably due to not allowing in the calculation for the density of the alpha-phase being somewhat lower than that of pure iron. The indications are that the carbide phases formed both in tempering and deformation are of the same nature. Electron-diffraction studies were also carried out to show how much easier the magnetic method is for a qualitative determination of the phase composition of tempered and deformed steel. A nickel steel (1% C, 4% Ni, chosen because of the high stability of its χ-carbide), U12 steel (tempered for 1 hour at 400 °C) and U12 steel (deformed to 50% after normalization) were used. The magnetization-versus-temperature curves showed all three types of material to contain Fe_3C, Fe_2C and alpha-solid solution. Residues from electrolytically-dissolved specimens were also used for obtaining such curves and for electron-diffraction study and, after compressing the powder into

Card 3/4

Some physical properties of ... S/126/61/012/003/012/021
E111/E335

a 4-mm diameter rod, for magnetic measurements. The similar phase-composition of solid-steel specimens and of the residue separated from these indicates that the observed kink in the magnetization-vs-temperature curve cannot be due to strains in the cementite; the present results support those authors who have emphasised the discrepancies in electron-diffraction patterns of such materials and postulated the existence of χ-carbide as a phase distinct from cementite. There are 3 figures, 3 tables and 7 references: 6 Soviet-bloc and 1 non-Soviet-bloc. The English-language reference quoted is: Ref. 5 - Z.S. Hofer, E.M. Kohn and W.C. Peebles - J. Amer. Chem. Soc., 1949, 71, 1.

ASSOCIATION: Gor'kovskiy issledovatel'skiy fiziko-tekhnicheskiy institut (Gor'kiy Physicotechnical Research Institute)

SUBMITTED: September 27. 1960 (initially)
April 15, 1961 (after revision)

Card 4/4

S/032/61/027/004/005/028
B110/B215

AUTHORS: Apayev, B. A. and Sysuyev, Yu. A.

TITLE: Dimensions and shapes of test specimens for magnetometric studies

PERIODICAL: Zavodskaya laboratoriya, v. 27, no. 4, 1961, 414-416

TEXT: Intensity of magnetization in quantitative magnetometric examinations depends on the demagnetization factor which is a function of shape, dimensions, and structure of the specimen. Two series (I) and (II) of specimens of У10 (U 10) steel were produced: series (I) with different lengths and equal diameters, (II) with different diameters and equal lengths. D. S. Shteynberg's magnetometer with ballistic measuring scheme was used. Experimental results showed the saturation of the specimen attainable in practical application at a field tension of H = 8000 oersteds which was used for several experiments. Fig. 2 shows the dependence of magnetization intensity on the dimensions of the specimen. Saturation is practically obtained at a ratio of $l/d > 10$ at 8000 oersteds. A ratio of $l/d > 10$ is required for quantitative determinations of carbon steels with a C content $\leqslant 1.0$ %. These dimensions are also suitable for magnetic saturation of low- and medium-alloy steels at 8000 oersteds. At 20 and 300°C, the intensity of magnetization was found to be proportional to the cross-sectional area (Fig. 26). In specimens of different diameters, the linear dependence of $J_s(S)$ allowed a quantitative comparison of measurements, and the reduction to a standard specimen. The method of Ref. 1 (B. A. Apayev, B. M. Yakovlev: Fizika metallov i metallovedeniye. 10, 4 (1960)) was used to calculate phases according to the magnetogram. For the examination of practical specimens of irregular geometric shapes it is necessary to know the magnetization intensity (J_s) of phase components of the examined system, and the fraction of the intensity of magnetization (Δa_i) of comparable specimens at equal temperatures. Should there be a number of ferromagnetic phases, the percentage by volume (P_i) of the phases according to the principle of additivity is as follows: $P_1 = (\Delta a_1/a_1)\cdot 100\%$; $P_2 = (\Delta a_2/a_2)\cdot 100\%$; .... $P_i = (\Delta a_i/a_i)\cdot 100\%$ $\sum_1^i P_i = 100$, (1) with $a_1, a_2 \ldots\ldots a_i$ standing for the specific intensity of magnetization expressed in mm on the galvanometer scale, and $\Delta\alpha_1$, $\Delta\alpha_2$....$\Delta\alpha_i$ the fractions of magnetization of phases 1,2,...i taken from the magnetogram. By using the ballistic magnetometer in saturated magnetic fields, the following equation is obtained: $\alpha_1/\alpha_i = J_1/J_i$; $\alpha_2/\alpha_i = J_2/J_i$; ..... $\alpha_{i-1}/\alpha_i = J_{i-1}/J_i$ (2). From (1) and (2), we obtain for the specific magnetization:

$\alpha_i = \Delta\alpha_i + \Delta\alpha_1\cdot(J_i/J_1) + \Delta\alpha_2\cdot(J_i/J_2) + \Delta\alpha_3\cdot(J_i/J_3) + \ldots + \Delta\alpha_{i-1}\cdot(J_i/J_{i-1})$.

Example: the carbon content of a specimen of any dimensions of hardened У 10 (U 10) steel is to be determined (Fig. 4). In the course of the magnetogram ferrite and cementite were found to be constituents. Extrapolation of the ferrite section of the curve for room temperature yields the quantities $\Delta\alpha_f$ and $\Delta\alpha_c$. At room temperature, J_f (of ferrite) = 1685 oersteds, J_c (of cementite) = 923 oersteds. From formulas (1) and (3) a carbon content of 1.018% was obtained. It differed from the analytical value of 0.99% by 0.028%. There are 4 figures and 3 references: 2 Soviet-bloc and 1 non-Soviet-bloc.

Dimensions and shapes of test... S/032/61/027/004/005/028
B110/B215

ASSOCIATION: Gor'kovskiy issledovatel'skiy fiziko-tekhnicheskiy institut (Gor'kiy Physical and Technical Research Institute)

Legend to Fig. 2: Change in intensity of magnetization as dependent on length (a) and diameter (б) of the specimen at 20°C (I) and 300°C (II).

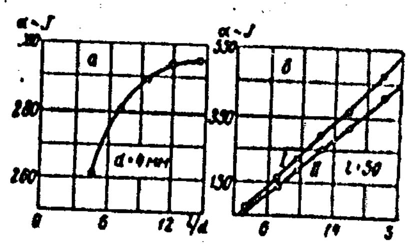

FIG. 2

Card 4/5

Dimensions and shapes of test...

S/032/61/027/004/005/028
B110/B215

Legend to Fig. 4: Magnetogram of У 10 (U 10) steel: circles denoting experimental values and crosses calculated values.

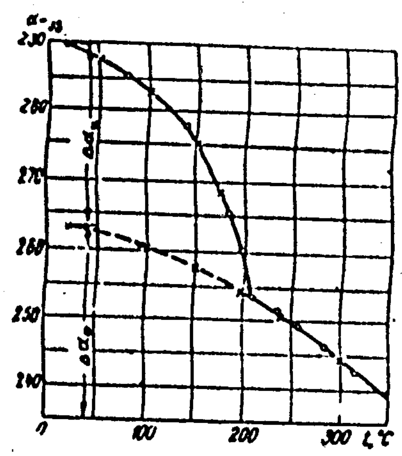

FIG.4 ✓

Card 5/5

...YEV, B. A.; KRASOTSKAYA, S. N., YAKOVLEV, B. M.

Effect of aluminum, copper, and carbon on carbide formation processes and graphitization during the quenching of hardened steels. Izv. vys. ucheb. zav.; chern. met. 7 no.6:1...-138 '64. (MIRA 17:7)

1. Gor'kovskiy issledovatel'skiy institut.

APAYEV, B.A.; BELOUS, M.V.; PERMYAKOV, V.G.

Calculating the additive properties of alloys during quantitative phase analysis. Fiz. met. i metalloved. 17 no.2:289-292 F '64. (MIRA 17:2)

1. Kiyevskiy politekhnicheskiy institut i Gor'kovskiy fiziko-tekhnicheskiy institut.

APAZIDI, G.D., inzh.; BOYKO, A.M., inzh.; SHARAPOV, A.V., inzh.

Rotary-piston engines of the Curtiss-Wright firm. Trakt. i sel'khozmash. 33 no.5:45-46 My '63. (MIRA 16:10)

1. Gosudarstvennyy soyuznyy nauchno-issledovatel'skiy traktornyy institut.

APAZIDI, G.D., inzh.; BOYKO, A.M., inzh.

Rotary-piston engines of the NSU make. Trakt. i sel'khozmash. 33 no.11:43-46 N '63. (MIRA 17:9)

1. Gosudarstvennyy soyuznyy nauchno-issledovatel'skiy traktornyy institut.

APAZIDI, G.D., inzh.; BOYKO, A.M., inzh.

Making a rotary-piston engine gas tight. Trakt. i sel'khozmash. no.7: 46-48 Jl '65. (MIRA 18:7)

1. Gosudarstvennyy soyuznyy nauchno-issledovatel'skiy traktornyy institut.

APAZIDI, L.Kh., nauchnyy sotrudnik

Development of the fungous causative agent of branchiomycosis in fish. Veterinariia 36 no.6:37-39 Je '59. (MIRA 12:10)

1. Vserossiyskiy nauchno-issledovatel'skiy institut prudovogo rybnogo khozyaystva.
(Fishes--Diseases and pests)
(Fungi, Pathogenic)

~~APASIDI, L. H.~~ APAZIDI, L. Kh.

"About aetiology of septicaemia haemorrhagica cyprinarum."

Veterinariya, Vol. 37, No. 7, 1960, p. 40

Sci. Collaborator, All-Union Sci. Res. Inst Fish Economy